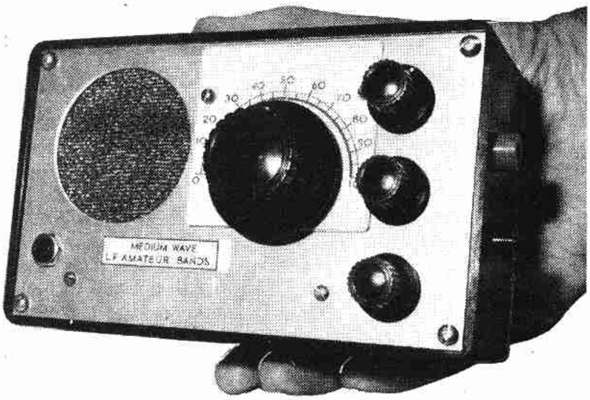
IC+2 RECEIVER

R.H. LONGDEN



THIS receiver uses an integrated circuit which provides mixer, oscillator, IF, detector and audio driver stages, with a ceramic filter in the IF position. A complementary push-pull audio output stage follows, to operate the speaker.

CIRCUIT DESIGN

The switching and tuning arrangements adopted are of a somewhat simple nature and the way in which the three bands are obtained will be clear from Fig. 1. VC1/VC2 is the tuning capacitor with an integral ball drive. The band switch has three poles. On "M", for medium wave reception, L1 and L2 are in series and tuned by VC1. VC2 tunes the oscillator coil, with padder C4 in circuit. S1 also places C2 across VC2. In these circumstances, oscillator coverage is approximately 1165 to 2020kHz. As the receiver intermediate frequency is 455kHz, the oscillator operating HF of the signal frequency, coverage is approximately 710-1565kHz. No pre-set trimmer is required in the oscillator circuit because the panel trimmer VC3 allows for peaking of the aerial circuit throughout the band.

With the switch at "160" C2 remains in circuit, but the padder is changed to C3. Oscillator coverage is now approximately 2160 to 2600kHz. The oscillator is HF of the signal frequency as before so the receiver tunes about 1705-2145kHz which includes the 160m band (1800-2000kHz). L1 and L2 remain in series, but aerial tuning coverage is reduced by TC2 in series with VC1, to obtain a suitable band.

With the switch at "80" S1 shorts out the MW section L2 leaving only the short wave winding L1 in use. C2 is no longer across VC2 and TC3 is in series with C4. As a result, oscillator coverage is approximately 3045 to 3415kHz. The oscillator is now on the LF side of the signal frequency giving a band of about 3500-3870kHz for 80m reception. TC1 is in series with VC1 providing suitable coverage in the aerial circuit.

Alignment of these circuits is not particularly tricky as VC3 is present on all bands allowing manual trimming. It should be noted that there is not a great deal of latitude in capacitor values. Capacitor C4 is larger than the usual padder because the oscillator coil has to be set to a somewhat lower inductance than normal, which is easily within the core adjustment. The circuit allows effective bandspreading of 160m and 80m plus most of the usual MW coverage without the switching otherwise necessary to select alternative oscillator coils for the various bands.

CIRCUIT DETAILS

The pins of IC1 are numbered as seen from below, Fig. 2. The aerial coil point 5 goes to the mixer base pin 1. Pin 3 is for the mixer emitter circuit with emitter bias components R2, R3 and C9. Pin 4 is the input of the audio amplifier, with pin 5 for negative feedback from the output transistors, via R16. Pin 6 is the audio section output, driving Tr1 and Tr2. Pin 7 is the IC earth line.

Pin 8 is the audio output going to volume control VR1, and AGC bias via R4 and R5 to control the gain of earlier stages. Pin 9 is the IC positive supply point. Pins 10 and 11 are the IF amplifier input, with by-pass capacitor C8 on pin 11.

Pins 12 and 13 are collector and emitter circuits of the IC oscillator, and go to the oscillator coil. Pin 14 is the mixer output in conjunction with pin 2, which is earthed via C7.

The IC is effectively 14 transistors, the end occupied by pins 1 and 14 being identified as shown in Fig. 2.

External connections only for the CFT455C filter are shown, pins are bridged and connected to place the ceramic filter in series with the coupling windings.

The output transistors employ emitter resistors R14 and R15 to stabilise working conditions the circuit being satisfactory for a loudspeaker of 8 ohms or over. A speaker of up to 75 ohms may be used, though output falls off a little, and a somewhat

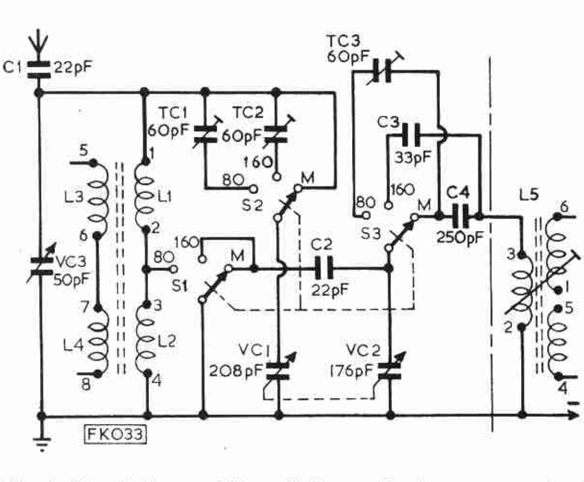


Fig. 1: Circuit diagram of the switching and tuning arrangements of the receiver. Connections to L3, L4 and L5 are shown in Fig. 2.

lower impedance (but not under 8 ohms) is more suitable. Low impedance phones may be plugged into the jack socket, for personnal listening.

CONSTRUCTION

The receiver, with speaker and battery, was constructed to fit a case $6\times3\frac{1}{2}\times1\frac{3}{4}$in. internal dimensions, as a pocket set giving good 80m and 160m amateur band reception in addition to normal MW reception. The whole circuit of Fig. 2, with the exception of the aerial, VR1 and speaker, is assembled on 0·1in matrix plain Veroboard. In order that the components may be readily accommodated, it is most convenient to use the $\frac{1}{4}$ watt resistors sometimes listed as "miniature". The capacitors are also of small size, and except for the electrolytics, are mostly low voltage disc ceramic.

The board is approximately $4\frac{1}{4}\times1\frac{5}{8}$in, and components can be located from Fig. 3. Holes are first drilled to take the pins of the oscillator coil, IF filter and for bolts to secure the two angle brackets which attach the board to the receiver panel and which also form the earth return connecting points. Tags are fitted for this purpose. In most places the wire ends of resistors and capacitors can reach between the connecting points. Where other connections are required, these can be 24SWG tinned copper or similar wire. Insulating sleeving is necessary on many leads and different colours can be used to identify various connections.

When soldering to the IC, the same care to avoid overheating should be taken as when soldering the transistors. With the latter, short pieces of green sleeving were put on the emitter leads with white on the collector leads, to avoid possible short circuits and provide easy identification of connections. Flying leads are provided from R7, for VR1 centre tag and from R6/C12, also for VR1. The remaining VR1 tag is wired to chassis. Leads from C18 positive and the positive line run to the speaker. A red lead from C14 positive is fitted with a positive battery clip.

The bridging connections on the IF filter should not be overlooked and connections must not touch unused pins. C3 and C4 are soldered to pin 3 of the oscillator coil and will go to S3. C10 has short leads to pins 8 and 9 of IC1.

A small soldering iron is necessary and care must be taken not to form very large joints or to bridge adjacent points with solder. The layout of components is quite compact though there is some free space.

★ components list

Resistors

R1	22kΩ	R8	27kΩ	R15	2·2Ω
R2	150Ω	R9	470Ω	R16	15kΩ
R3	820Ω	R10	10kΩ	R17	10kΩ
R4	8·2kΩ	R11	100Ω	R18	220kΩ
R5	8·2kΩ	R12	680Ω	R19	2·7kΩ
R6	390Ω	R13	47Ω		
R7	1kΩ	R14	2·2Ω		

All resistors are 5% ¼ watt
VR1 5kΩ log. potentiometer with switch S4

Capacitors

C1	22pF	C8	0·047μF	C15	0·25μF
C2	22pF	C9	0·047μF	C16	0·01μF
C3	33pF	C10	0·047μF	C17	32μF 6·4V
C4	250pF	C11	10μF 6·4V	C18	320μF 6·4V
C5	0·047μF	C12	0·1μF	C19	100pF
C6	0·1μF	C13	320μF 6·4V	C20	680pF
C7	0·1μF	C14	220μF 10V	C21	0·047μF

VC1/VC2 208/176pF gang (Jackson Type 00 with slow motion)
VC3 50pF variable (Jackson Type C804)
VC4 20pF variable (Jackson Type C1604)
TC1/2/3 60pF compression pre-sets

Semiconductors

IC1 TAD100 Tr1 AC141 Tr2 AC142 Tr3 ZTX108 or similar

Miscellaneous

Ferrite rod aerial (Denco 5in. with MW winding only). Oscillator coil L5 (Denco TOC1). Filter F1 CTF455C (Ambit). Switch S1/2/3 3 pole 3 way rotary wafer. S5 slide switch. Speaker 8 ohm 2½in. but see text. Insulated jack socket 3·5mm. Veroboard, see text. Knobs.

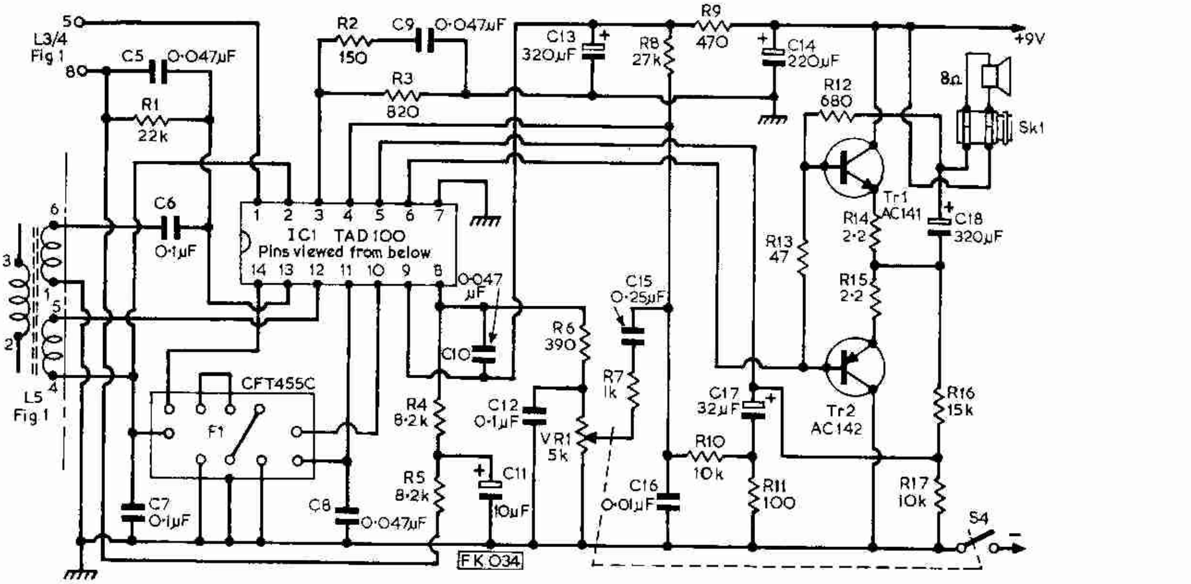


Fig. 2: Circuit diagram of the receiver and amplifier sections of the 'IC + 2'

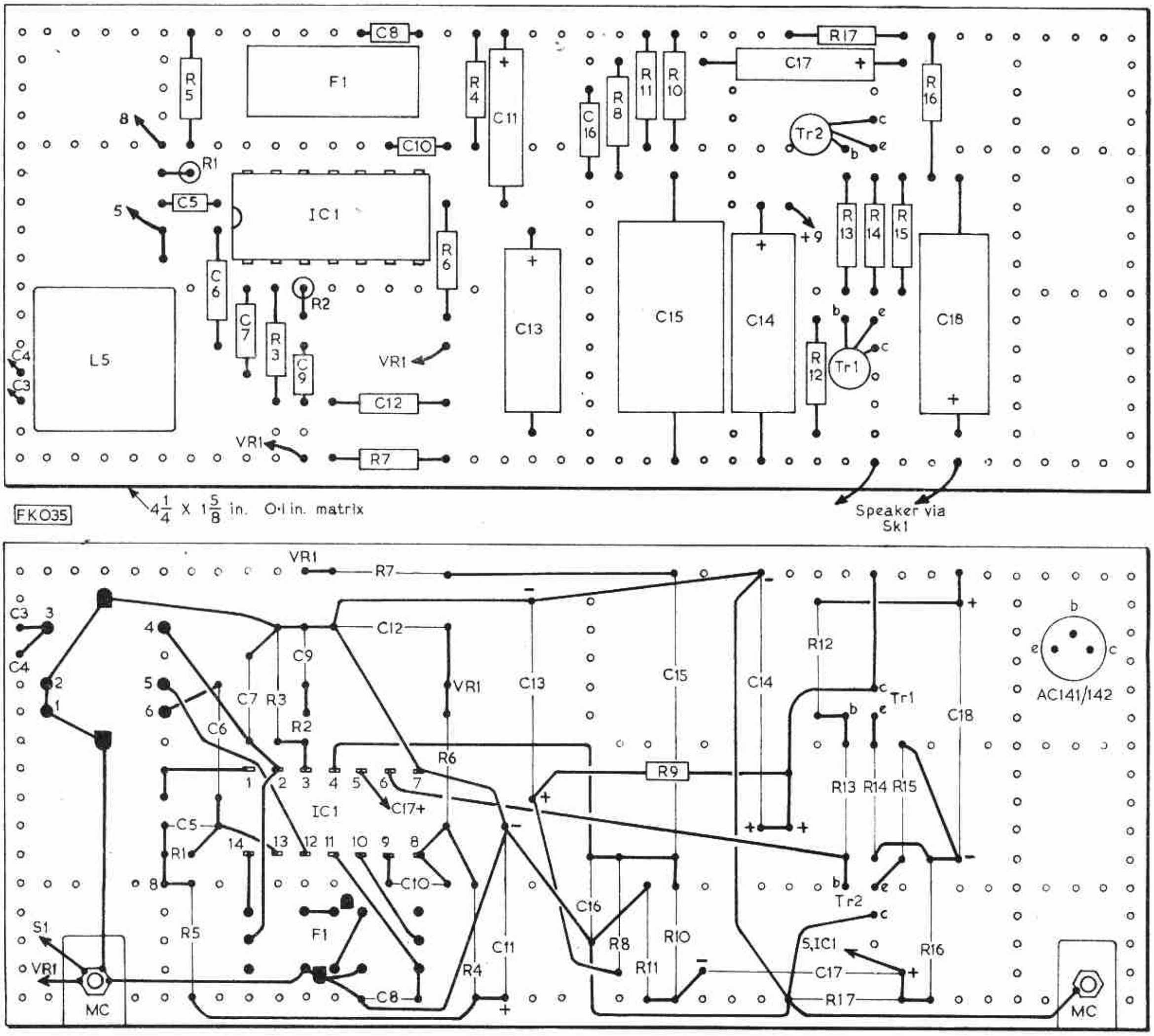


Fig. 3: Component layout on the perforated board. Use insulated wire for the underside wiring.

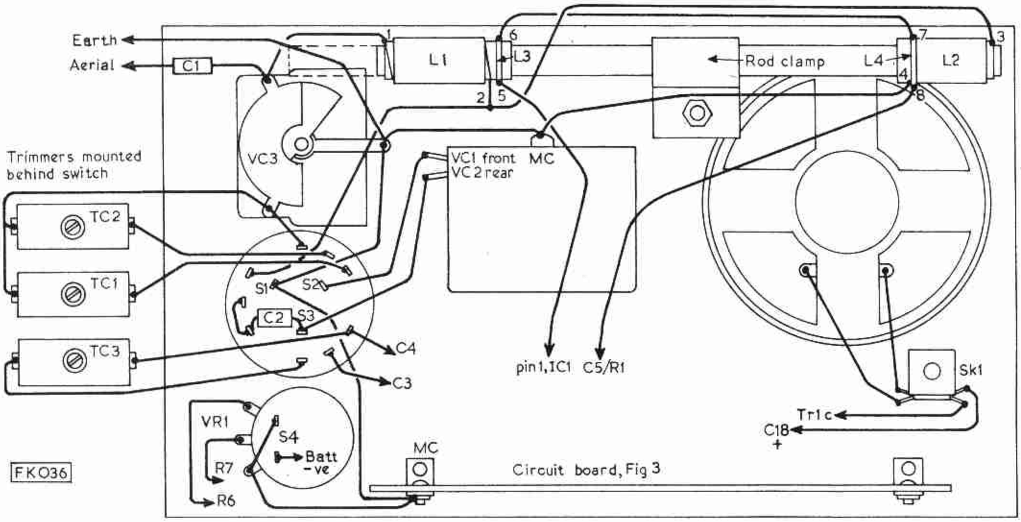


Fig. 4: Front panel component location and interwiring. Capacitors C3 and C4 are mounted between the board and the front panel.

The whole receiver is assembled on the panel of the case, so that it can be tested and adjusted easily. Connections here can be seen from Fig. 4.

VC1/VC2 is fixed with three 4BA countersunk bolts and is set back a little by placing extra unts or washers between the capacitor and panel. If this is not done the control knob will project much more than necessary, since the spindle could, in any case, only be cut down very little, due to the integral reduction drive. VC1 is the front section, having most plates, and VC2 the rear section.

The rotary switch is wired as shown except for the trimmers. These are then mounted by using 18 SWG or other stout wire directly to VC3 and the switch tags. These three trimmers are directly behind the switch.

FERRITE AERIAL

A $1\frac{1}{2}$in 6BA bolt passes through the panel and a spacer or extra nuts allows the rod to be clamped as in Fig. 4, by passing a strip of stout card round it.

A strip of paper about 1in to $1\frac{1}{2}$in long is wound round the end of the rod, with a little adhesive, forming a tube which will allow L1/L2 to be slid along the rod. L1 begins at 1, and is 30 turns of 26SWG enamelled wire, close wound, ending at 2. L3 is two turns of any thin insulated wire, say 34 SWG, near L1.

As the MW section L2 is intended for use by itself 17 turns are unwound from its outer end. All the individual strands of the wire must be carefully cleaned and soldered together. This lead is 3, Figs. 1 and 4. L1 and L2 must be so phased that beginning at 1, continuing on to 2 and 3, and then to 4, all turns are in the same direction.

L4, already present with L2, is modified to leave only three turns. L3 and L4 must be in the same direction, as explained for L1 and L2. It is worth noting that the receiver can be tested on medium waves only by connecting L2, unmodified, to VC1 and chassis, and L4 to C5 and 1, IC1. Position the winding on the rod so that VC3 peaks up signal throughout the range.

ALIGNMENT

This can be greatly simplified by using a signal generator or second receiver, but in any case efficiency is not lost provided VC3 can be rotated to peak up signals and is then not fully closed or fully open. However, band coverage does depend considerably on the trimmers and oscillator core setting.

If a calibrated receiver is available, place an insulated lead from its aerial socket near VC2. Switch to medium waves and close VC1/2. Unscrew the core of the oscillator coil until the oscillator frequency is 1165kHz, as shown by the receiver. If the receiver is not a type with a tuning indicator or BFO, the oscillator signal or carrier will be located only as a reduction in background noise, as when tuning in a station carrying no programme. The core can then be left in this position. Otherwise, unscrew the core a little, checking reception, until the MW band obtained is about 710-1565kHz. Any integral trimmers on the ganged capacitor should be left fully unscrewed.

Signals near the HF band end should peak up with VC3 about one-third closed. Position L2 on the rod so that VC3 is best in a similar position near the LF end of the band (VC1/2 nearly closed). With the switch at 160, coverage depends on C3, and no other adjustment is provided. If 1·8 to 2MHz cannot be tuned, the oscillator coil core is probably wrongly set. There is some latitude, this range being about 1705 to 2145kHz. TC2 is adjusted so that the aerial circuit coverage is suitable, shown by VC3 not needing to be fully open for best volume.

When the switch is at 80, oscillator coil coverage is adjusted with TC3. There is not much latitude here, though a little over 3·5 to 3·8MHz can be tuned with the full swing of VC1/2. It is then necessary to set TC1 and if necessary also modify the position of L1 on the rod, until aerial coverage is similar, again as shown by VC3 peaking signals when rotated.

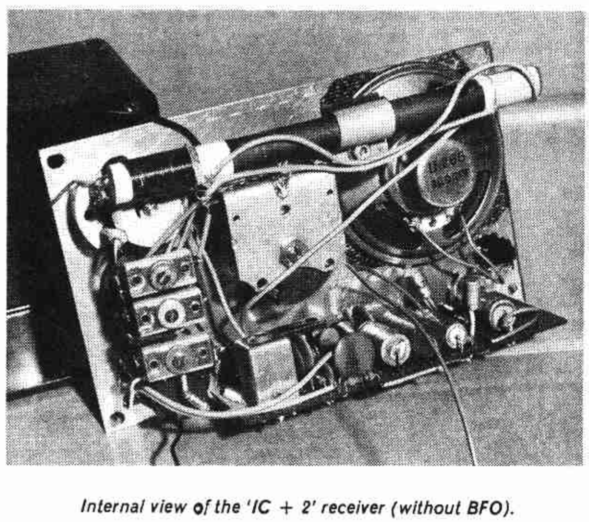
NOTES

MW reception will usually be by means of the internal ferrite rod, through an external aerial naturally increases range. The ferrite rod will give sufficient pick-up of strong local signals on the 80m and 160m bands. It may be necessary to make use of the directional effects of the aerial by turning the whole receiver. However, normally an external aerial will be provided for 80m and 160m.

This aerial increases range and signal strength so that more transmissions can be heard, even if it is only a relatively short indoor wire. The aerial lead goes to C1. If a very long aerial is available, a further small capacitor or preset of about 50pF maximum can be put in this lead. For best reception an earthed connection should also be available, as this can increase signal strength to a worthwhile extent.

The aerial and earth sockets are on the side of the case with thin flexible leads running to them. The phones socket must be of fully insulated type, or separately insulated from the metal panel.

The dial is $2\frac{3}{8} \times 2\frac{1}{4}$in with a scale marked 0-100. It is covered with a piece of thin Perspex of the same size, fixed with the bolt holding the ferrite rod mount, and a second bolt near VC3. A transparent cursor with a line marked on it can be drilled to be a tight fit on a small grommet, which firmly grips the $\frac{1}{4}$in. spindle. Alternatively, a metal pointer could be soldered on. A piece of metal is shaped to hold the battery against the end of the case, and is bolted inside the case.



Internal view of the 'IC + 2' receiver (without BFO).

OPTIONAL BFO

Broadcasts received on medium waves are AM or amplitude modulated and will be heard in the usual way. Some transmissions in the 160 and 80 metre bands are also AM. However, on the 80m amateur band in particular, a large number of single sideband and CW Morse transmissions will be present. A beat frequency oscillator is necessary to receive these and this can be assembled on the space provided at the end of the board, near the speaker. The BFO is **not** in use for the reception of AM signals, on any frequency.

Fig. 5 is the circuit of the BFO which is brought into operation by closing S5. The panel control VC4 allows fine adjustment of BFO frequency.

As the BFO pitch control now occupies the hole used for the phone socket, this has to be moved to the side of the case. It is also necessary to position the battery immediately against the speaker, and near the ferrite rod, so as to clear VC4 and the coil.

The coil is wound with 38SWG wire, Fig. 6. L6 has 165 turns and L7 has 40 turns. The former is approximately 7mm in diameter with an adjustable core. Begin winding near the base of the former, this being point C. Wind L6 in a pile occupying about 8mm winding length, ending at D. Leave a space of about 1mm and begin at A, winding L7 in a pile occupying about 4mm and terminating at B. The windings can be secured with a little adhesive and the ends are left long enough to reach the various connecting points.

Components for this stage are positioned and wired as in Fig. 6. S5 is a miniature slide switch, fitted in a slot near the speaker. VC4 is also a miniature component, secured with its bush nut. As the spindle of the specified VC4 is not ¼in in diameter, it is necessary to obtain a knob with a small hole, or to cut and shape a small piece of metal to pack out the spindle diameter. Or drill a ½in length of plastic rod ¼in in diameter to fit the capacitor shaft.

No additional coupling into the receiver circuit was found necessary, other than that provided by stray capacitance and the unscreened coil.

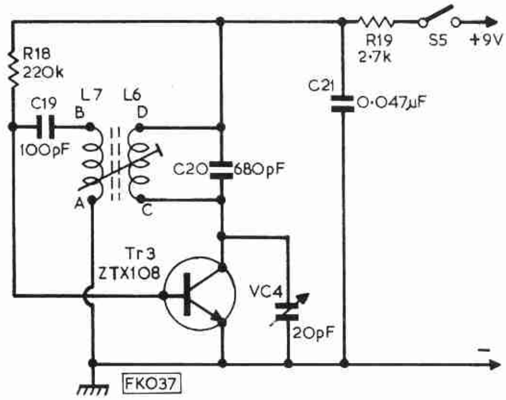


Fig. 5: Circuit diagram of the beat frequency oscillator.

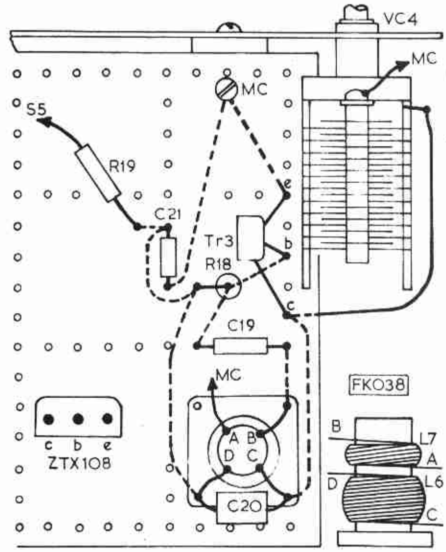
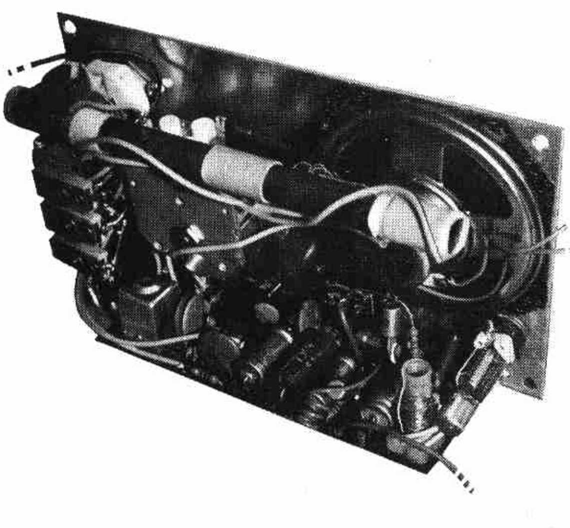


Fig. 6: Layout of the BFO components on the perforated board. The variable capacitor VC4 occupies the hole previously used for the jack socket.



The 'IC + 2' receiver with the extra BFO components added.

BFO ADJUSTMENT

The BFO can have no effect until it is adjusted to about the same frequency as the receiver intermediate frequency of 455kHz. To do this, half closeVC4 and rotate the core of L6 until a strong heterodyne accompanies any AM signal tuned in. This is probably most easily done on the MW band. Check with more than one station to make sure the heterodyne is not a harmonic reaching the aerial circuit.

To receive CW, close S5 and adjust VC4 for the best note. For SSB reception, very careful adjustment of receiver tuning and VC4 are necessary. When CW or SSB signals are very strong, the aerial trimmer should be set to reduce them in power, so that VR1 can be near maximum gain. In this way the carrier of the BFO has sufficient strength to allow proper detection. A little use will soon show how the BFO control is adjusted.